Implementation of wind power in RES2020-TIMES

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TIMES features for wind implementation

Objective function

- Investment costs (with taxes and subsidies)
- Fixed annual costs
- Variable annual costs – cost increase from wind
- Elastic demand – consumer response to spot prices (cost of demand reductions)

Time slices

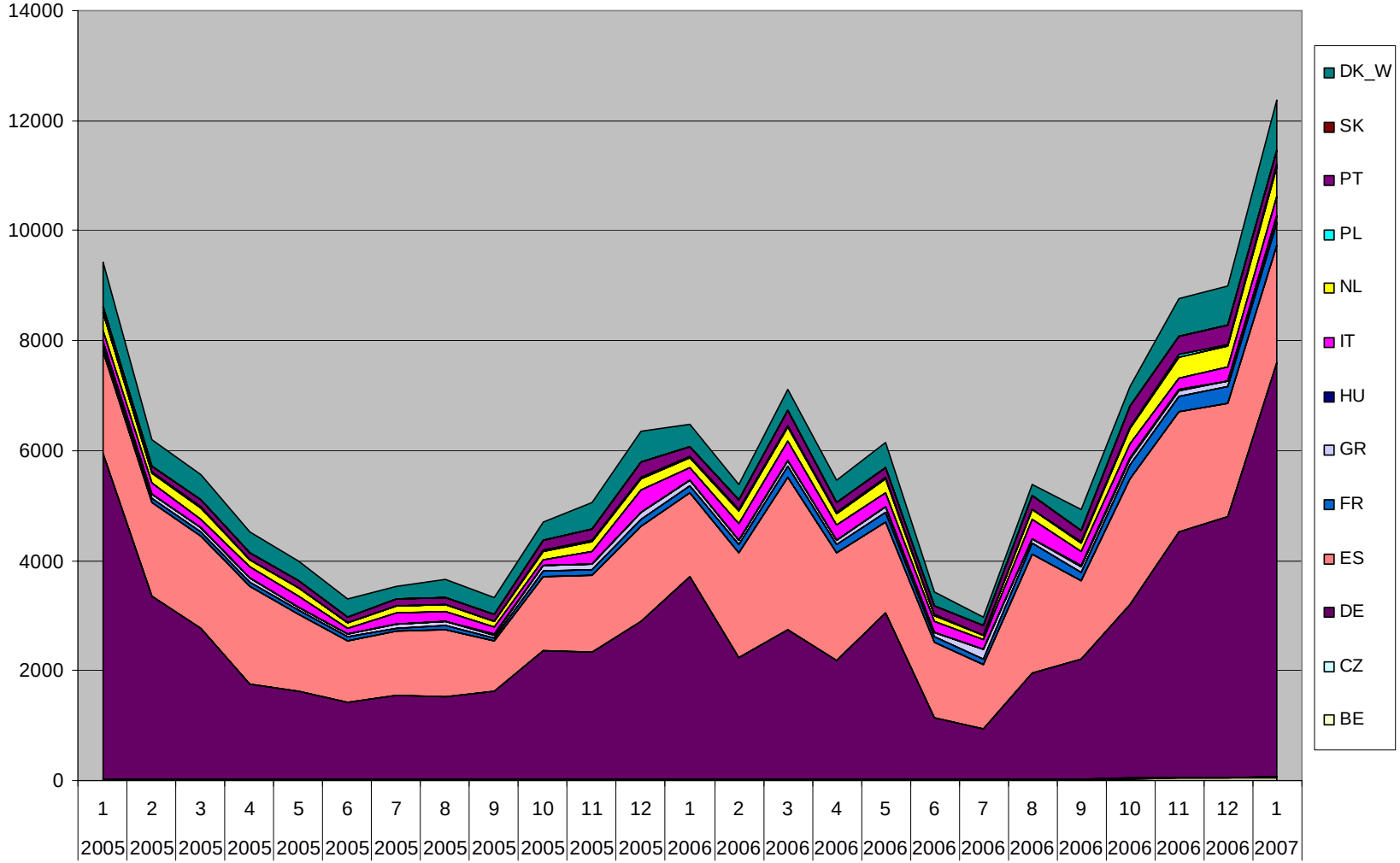
- Contribution to peak demand
- 4 seasons: Spring, Summer, Fall, Winter
- 3 diurnal: Day, Night, Peak
- Additional time slices with wind availability: Full, average or no wind

Constraints

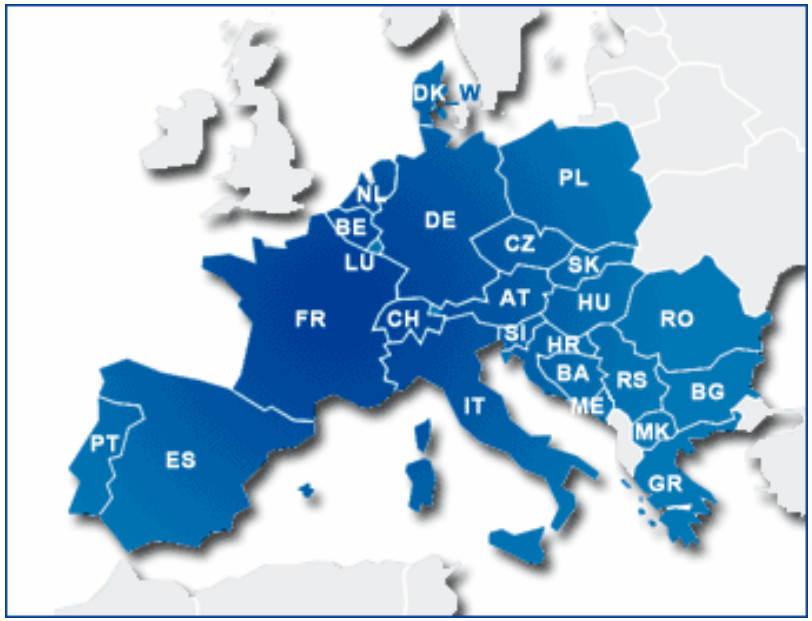
- Upper and lower limits for installed wind capacity and production
- Exogenous investments

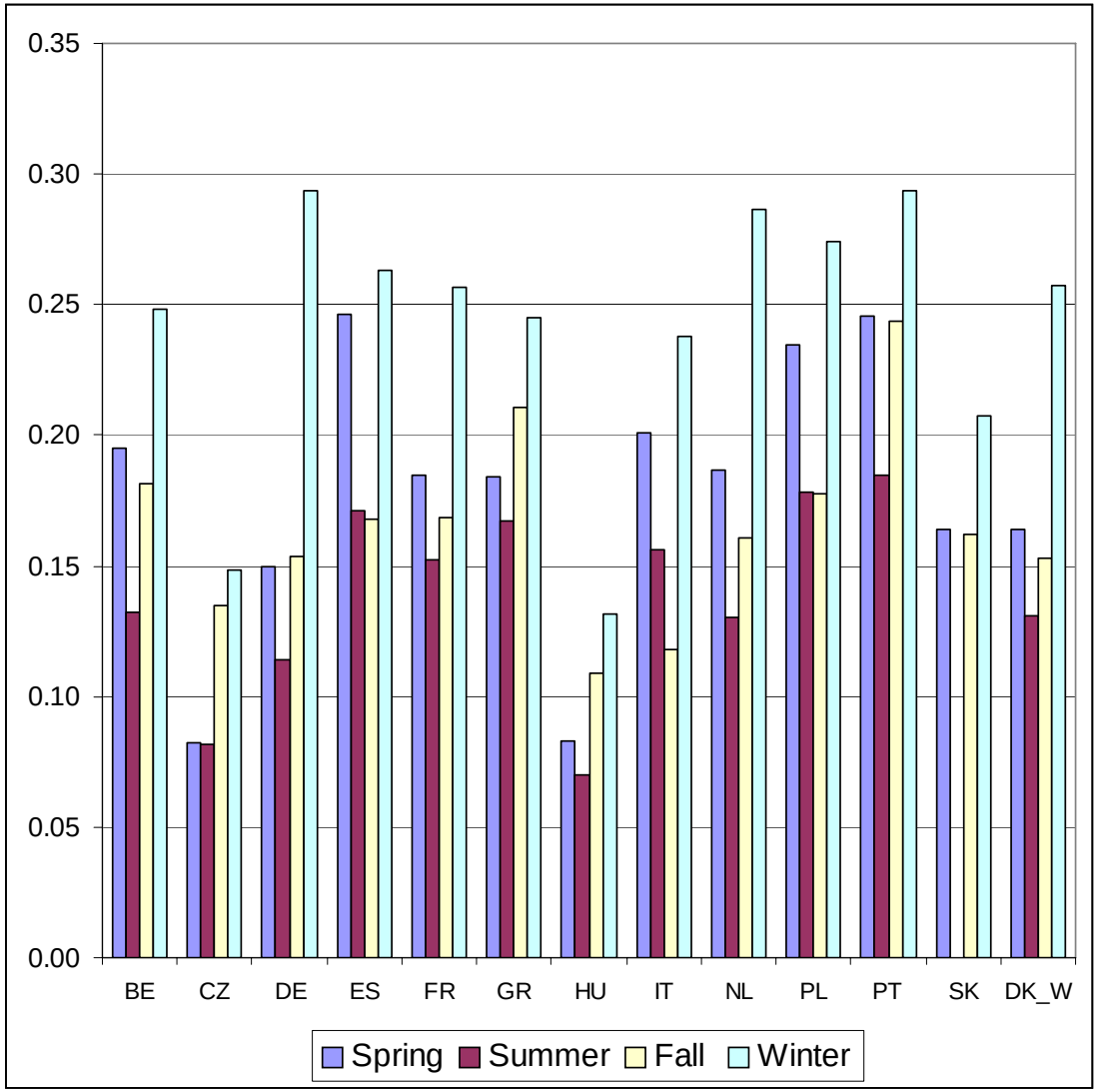
Note: Stochastic TIMES is not applicable – it is a very different approach

Monthly wind production in UCTE countries 2005-06



UCTE statistics for wind 2005





UCTE:
Monthly statistics for wind production since 2005
EWEA:
Wind capacities by end of year.

Note: The two sources may be inconsistent.

Seasonal load factor for wind – national data

Denmark 2000-06, *Spain 2003-06,* Greece average year

	2000	2001	2002	2003	2004	2005	2006	Average
spRing	0.14	0.19	0.15	0.19 *0.25*	0.23 *0.26*	0.21 *0.26*	0.24 *0.27*	0.19 *0.26* 0.26
Summer	0.17	0.15	0.15	0.16 *0.17*	0.19 *0.20*	0.18 *0.22*	0.11 *0.20*	0.16 *0.20* 0.33
Fall	0.25	0.24	0.17	0.20 *0.23*	0.26 *0.25*	0.22 *0.24*	0.26 *0.24*	0.23 *0.24* 0.24
Winter	0.30	0.21	0.29	0.26 *0.33*	0.27 *0.30*	0.32 *0.31*	0.27 *0.24*	0.27 *0.29* 0.34
Annual average	0.22	0.20	0.20	0.21 *0.24*	0.24 *0.25*	0.24 *0.26*	0.22 *0.24*	0.22 *0.25* 0.30

TIMES: Wind availabilities in time slices – GR and DK

~FI_T

Attribute	RD	RN	RP	SD	SN	SP	FD	FN	FP	WD	WN	WP	
YRFR	0.097	0.105	0.009	0.114	0.125	0.010	0.097	0.105	0.009	0.151	0.164	0.014	1.000

Util factor	AF~RD	AF~RN	AF~RP	AF~SD	AF~SN	AF~SP	AF~FD	AF~FN	AF~FP	AF~WD	AF~WN	AF~WP	
GR	0.27	0.24	0.29	0.37	0.29	0.37	0.25	0.22	0.24	0.35	0.33	0.34	0.30
DK	0.22	0.17	0.24	0.18	0.13	0.21	0.25	0.21	0.25	0.28	0.27	0.27	0.22
DK Percentage of GR													
	0.80	0.71	0.84	0.49	0.45	0.56	1.00	0.95	1.03	0.80	0.80	0.79	0.73
DK Percentage of average													
DK-2000	71%	74%	75%	109%	102%	113%	109%	106%	107%	110%	107%	110%	101%
DK-2001	102%	93%	99%	99%	89%	97%	107%	103%	105%	78%	76%	78%	90%
DK-2002	81%	75%	82%	97%	88%	98%	77%	74%	77%	106%	107%	108%	92%
DK-2003	100%	91%	101%	101%	107%	100%	89%	91%	90%	91%	96%	94%	95%
DK-2004	113%	131%	113%	119%	123%	119%	116%	112%	117%	100%	96%	94%	110%
DK-2005	107%	110%	107%	108%	117%	107%	93%	97%	94%	119%	119%	116%	110%
DK-2006	125%	125%	123%	67%	74%	66%	110%	117%	110%	97%	99%	99%	101%

For an average year wind resources in DK are 30 % lower than GR

DK 2000-2006 more than 30 % variation from average in some time slices, but no more than 10 % for whole years

Wind power: Use of time slices

Analysis of hourly electricity demand and wind production for Denmark (east and west) 2000-06

- Most wind in winter and during day
- Annual resource availability between 20 and 24 % of installed capacity
- Resource availability less than 1 % during 2-10 % of seasonal hours
- Resource availability more than 75 % during less than 1 % of spring and summer hours, and up to 5 % of fall and winter hours

Proposal for use of TIMES time shares (Brussels, April 2007)

- Peak hour: No wind
- Night: seasonal average for wind
- Day: above seasonal average for wind
- Low demand / high wind shall not be considered by time slices, but only as additional costs

Wind power and capacity requirement

Requirement for non-intermittent capacity in TIMES

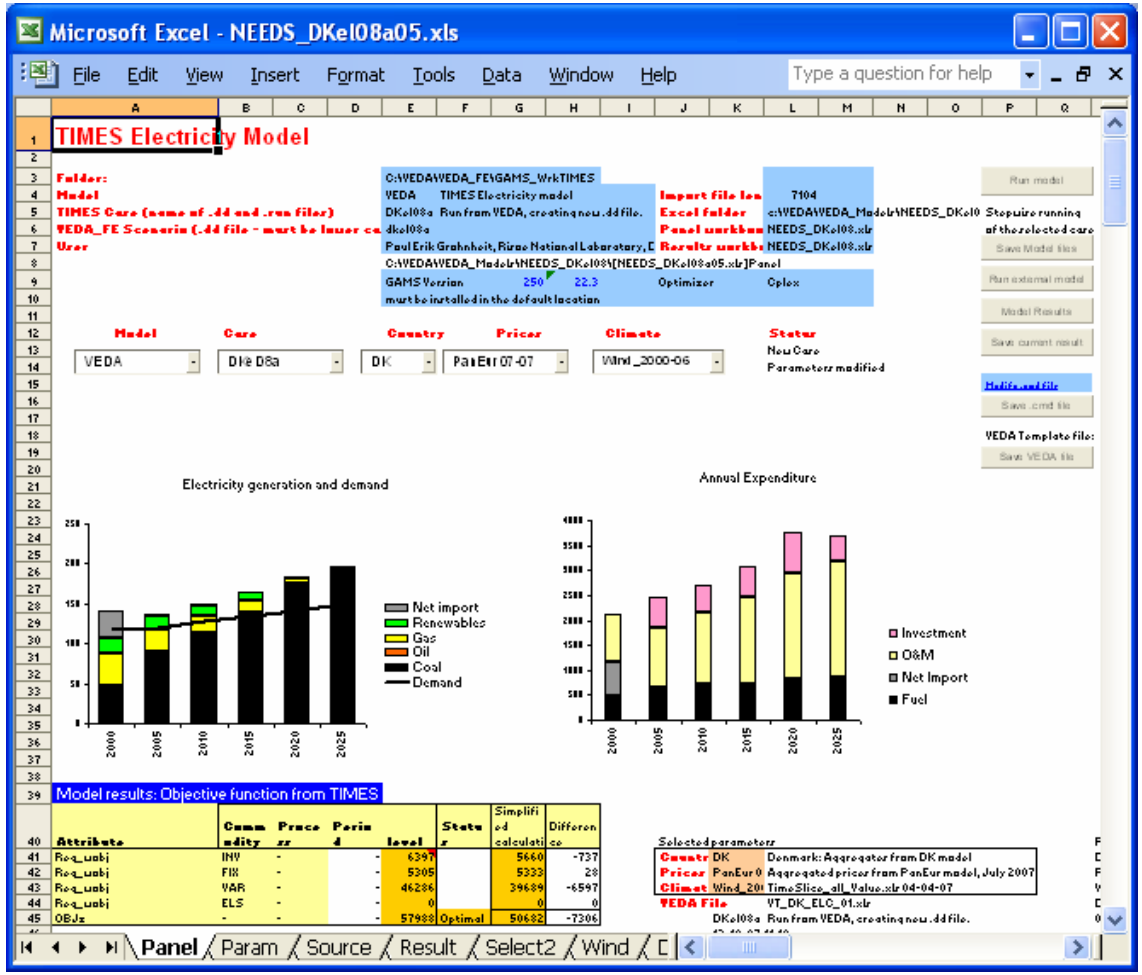
- Winter peak hour
  - *plus* Additional capacity needed for absolute peak
  - *plus* Reserve capacity
  - *minus* Capacity value of wind power
  - *minus* Impact of elastic demand

Conclusion

- Capacity value of wind power is probably the smallest of these uncertainties.
- Data for these items must be based on studies that are more detailed than TIMES
- Should be analysed using a small model focusing on wind power and including a few thermal technologies

Small TIMES model focusing on wind power

- More than a demo model for TIMES
- All data in a single workbook
- Choice of sets of parameters for
  - Demand (region/nation)
  - Fuel prices
  - Climate (wind availability)
- Capture of results for a large number of scenarios
- VEDA-FE for development
- Running with or without VEDA-FE and VEDA-BE in any combination



Small TIMES models – Capture of results

Microsoft Excel - NEEDS_DKel08a05.xls

File Edit View Insert Format Tools Data Window Help

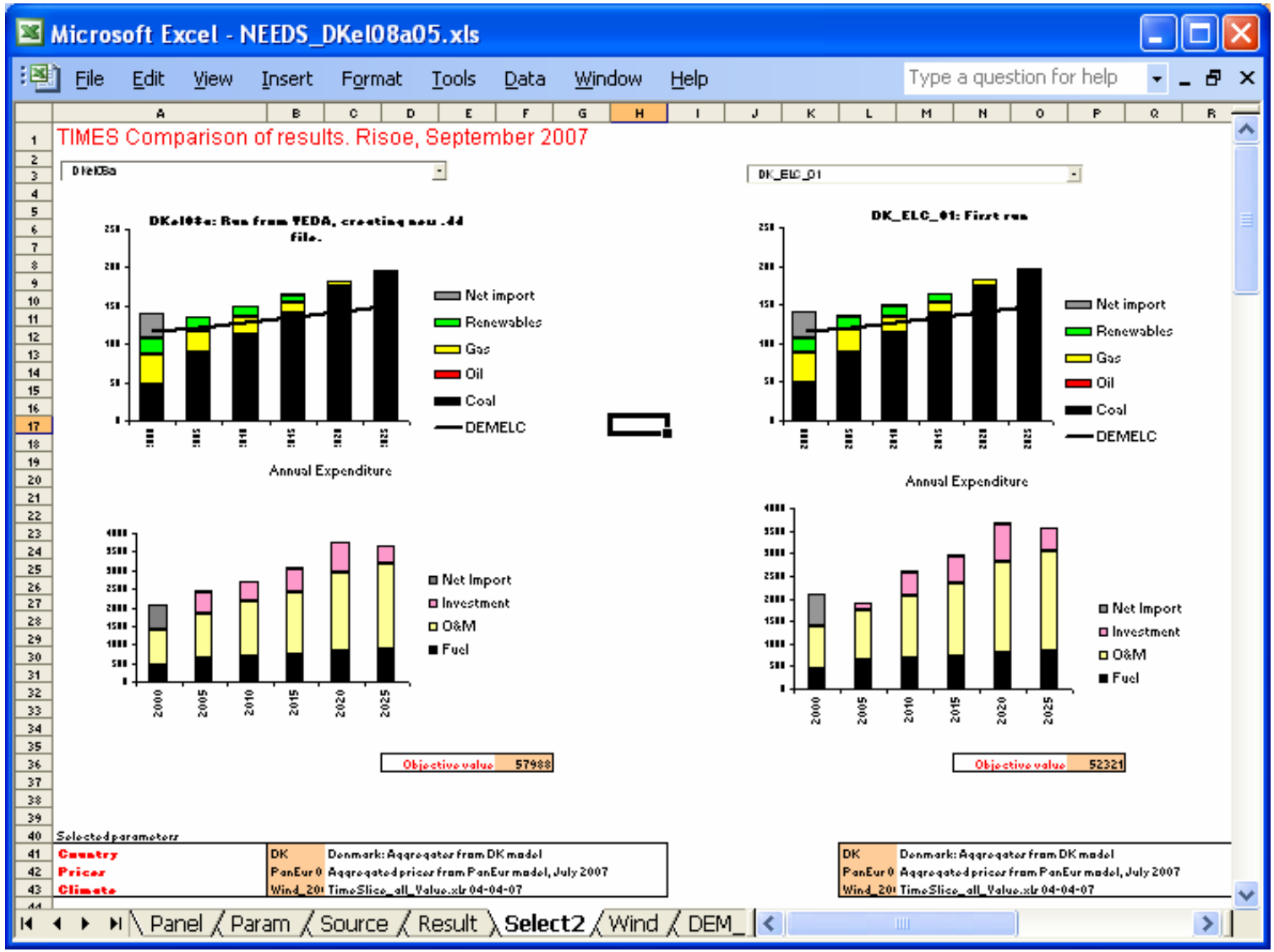
Type a question for help

	A	B	C	D	E	F	G	H	I	J	K
1					General						VAR_Nc
2	Case	Id	Description	Model	Objective Value	Status	Discount rate	Country	Prices	Climate	EUWINON301 2005
3	DKel08a	12-10-07 11:10	Run from VEDA, creating new .dc	VEDA	57988	Optimal	0.04	DK	PanEur 07	Wind_200	0.6
4	Field info	Date-time	Description	Model	Value	Status	Rate	ParamSet	ParamSet	ParamSet	VAR_Nc
5	DKel08a	01-10-07 18:40	Run from VEDA, creating new .dc	VEDA	57988	Optimal	0.04	DK	PanEur 07	Wind_200	0.6
6	DK_ELC_01	30-09-07 23:35	First run	VEDA	52321	Optimal	0.04	DK	PanEur 07	Wind_200	0.6
7	DKel07n7	06-09-07 14:33	Wind_2000-06	TIMES	53876	Optimal	0.04	DK 2000	PanEur 07	Wind_200	0.6
8	DKel07n6	06-09-07 14:32	Wind_2006	TIMES	53813	Optimal	0.04	DK 2000	PanEur 07	Wind_200	0.6
9	DKel07n5	06-09-07 14:32	Wind_2005	TIMES	53396	Optimal	0.04	DK 2000	PanEur 07	Wind_200	0.6
10	DKel07n4	06-09-07 14:31	Wind_2004	TIMES	53422	Optimal	0.04	DK 2000	PanEur 07	Wind_200	0.6
11	DKel07n3	06-09-07 14:29	Wind_2003	TIMES	54098	Optimal	0.04	DK 2000	PanEur 07	Wind_200	0.6
12	DKel07n2	06-09-07 14:24	Wind_2002	TIMES	54244	Optimal	0.04	DK 2000	PanEur 07	Wind_200	0.6
13	DKel07n1	06-09-07 14:11	Wind_2001	TIMES	54328	Optimal	0.04	DK 2000	PanEur 07	Wind_200	0.6

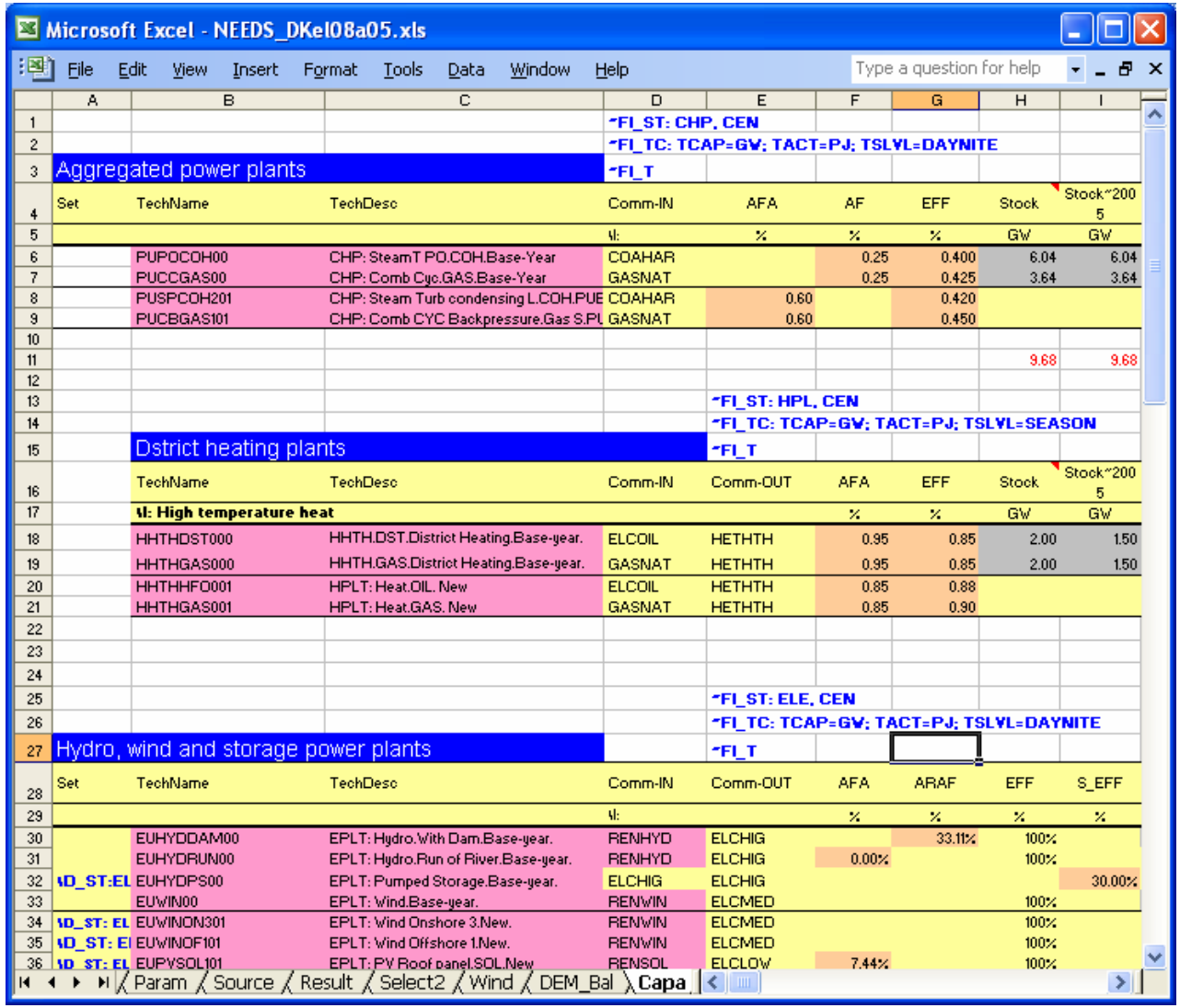
Panel / Param / Source / **Result** / Select2 / Wind / DEM_Bal / Capa

Capturing Scenario identification, sets of parameters and result variables (max. 256 items)

Small TIMES models – Comparing stored results



Small TIMES models – VEDA templates



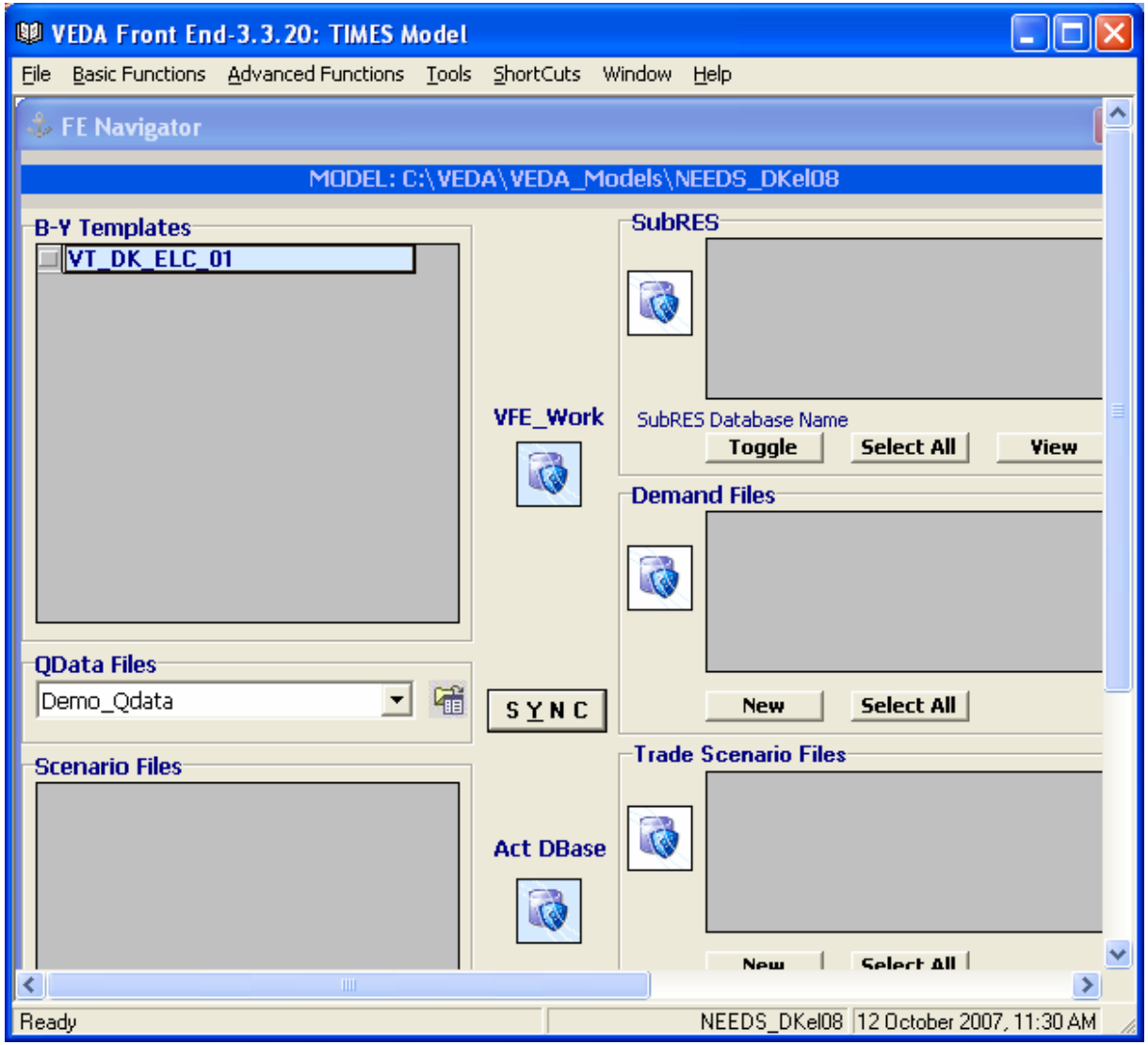
Microsoft Excel - NEEDS_DKel08a05.xls

File Edit View Insert Format Tools Data Window Help — Type a question for help

	A	B	C	D	E	F	G	H	I
1				*FI_ST: CHP, CEN					
2				*FI_TC: TCAP=GW; TACT=PJ; TSLVL=DAYNITE					
3	Aggregated power plants			*FI_T					
4	Set	TechName	TechDesc	Comm-IN	AFA	AF	EFF	Stock	Stock~2005
5				\I:	%	%	%	GW	GW
6		PUPOCOH00	CHP: SteamT PO.COH.Base-Year	COAHAR		0.25	0.400	6.04	6.04
7		PUCCGAS00	CHP: Comb Cyc.GAS.Base-Year	GASNAT		0.25	0.425	3.64	3.64
8		PUSPCOH201	CHP: Steam Turb condensing L.COH.PUE	COAHAR	0.60		0.420		
9		PUCBGAS101	CHP: Comb CYC Backpressure.Gas S.PU	GASNAT	0.60		0.450		
10									
11								9.68	9.68
12									
13					*FI_ST: HPL, CEN				
14					*FI_TC: TCAP=GW; TACT=PJ; TSLVL=SEASON				
15		Dstrict heating plants			*FI_T				
16		TechName	TechDesc	Comm-IN	Comm-OUT	AFA	EFF	Stock	Stock~2005
17		\I: High temperature heat				%	%	GW	GW
18		HHTHDST000	HHTH.DST.District Heating.Base-year.	ELCOIL	HETHTH	0.95	0.85	2.00	1.50
19		HHTHGAS000	HHTH.GAS.District Heating.Base-year.	GASNAT	HETHTH	0.95	0.85	2.00	1.50
20		HHTHHFO001	HPLT: Heat.OIL. New	ELCOIL	HETHTH	0.85	0.88		
21		HHTHGAS001	HPLT: Heat.GAS. New	GASNAT	HETHTH	0.85	0.90		
22									
23									
24									
25					*FI_ST: ELE, CEN				
26					*FI_TC: TCAP=GW; TACT=PJ; TSLVL=DAYNITE				
27	Hydro, wind and storage power plants				*FI_T				
28	Set	TechName	TechDesc	Comm-IN	Comm-OUT	AFA	ARAF	EFF	S_EFF
29				\I:		%	%	%	%
30		EUHYDDAM00	EPLT: Hydro.With Dam.Base-year.	RENHYD	ELCHIG		33.11%	100%	
31		EUHYDRUN00	EPLT: Hydro.Run of River.Base-year.	RENHYD	ELCHIG	0.00%		100%	
32	\D_ST:EL	EUHYDPS00	EPLT: Pumped Storage.Base-year.	ELCHIG	ELCHIG				30.00%
33		EUWIN00	EPLT: Wind.Base-year.	RENWIN	ELCMED			100%	
34	\D_ST: EL	EUWINON301	EPLT: Wind Onshore 3.New.	RENWIN	ELCMED			100%	
35	\D_ST: EL	EUWINOF101	EPLT: Wind Offshore 1.New.	RENWIN	ELCMED			100%	
36	\D_ST: EL	EUPVSOL101	EPLT: PV Roof panel.SOL.New	RENSOL	ELCLOW	7.44%		100%	

Param / Source / Result / Select2 / Wind / DEM_Bal / Capa

Small TIMES models – using the VEDA-FE navigator



Wind power in RES2020 - conclusions

- No additional details in model details to consider wind
- Careful implementation of time slices
- Convension on variation among time slices with variations of annual levels among countries, *or*
  Peak hour time slice may be used for the coincidence of high demand and no wind
- Addressing the coincidence of low demand and high wind only by adding integration costs
- Wind power capacity value is less important that other issues concerning capacity requirement
- Parameter analysis using a small model with few technologies, but full details of time slice parameters.
- Possibly exogenous data for installed wind – i.e. specified in the scenario description with feasibility check from more detailed models.